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Temporal structure of bursting patterns as representation of input history

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Single neurons exhibit complex dynamical repertoires, where interacting dynamics on many different time scales enable history-dependent forms of computation [1]. We investigate these phenomena in a biophysically realistic conductance-based model (similar to the one presented in [2]) of a bursting neuron from a crustacean Central Pattern Generator. The analysis is focused on the temporal structure of the bursting phase, describing how temporal patterns of spikes within bursts convey information about the previous history of stimulation to the cell. An electrophysiological mechanism for these behaviors is proposed, inferred from the geometrical structure of the system's phase space. We discuss the relevance of the phenomenon for homeostatic self-regulation of rhythmic activity in Central Pattern Generators, and as a possible communication mechanism between the CPG and higher centers in the nervous system. We are considering several experimental protocols to validate our theoretical work.

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